BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: Trip Report - 1973 Mars Lander Capsule Design Studies at Langley Research Center - Case 710

DATE: July 18, 1968

FROM: P. L. Chandeysson

ABSTRACT

Studies by McDonnell Douglas, Martin Marietta, and General Electric of landing capsules for a 1973 Mars orbiter-lander mission are discussed. Both hard and soft landers were considered. Several lander capsule point designs in the 2000 pound total (1000 pound landed) weight class were developed. These require the Titan-Centaur launch vehicle, and might be fitted within the 10 foot diameter Titan shroud. Soft landers appear more desirable because of the extensive data return specified. Less ambitious missions more suited to hard landers were not considered in these studies.

BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: Trip Report - 1973 Mars Lander Capsule Design Studies at Langley Research Center - Case 710

DATE: July 18, 1968

FROM: P. L. Chandeysson

MEMORANDUM FOR FILE

Introduction

On 25 June and 1-2 July 1968, W. B. Thompson and the author attended presentations of the results of three study contracts at Langley Research Center. McDonnell Douglas presented the final oral report on a study of a Mars soft lander capsule. The Martin Marietta Corporation gave a summary presentation of their study of direct versus orbital entry for Mars landing missions. The second oral report in a series of three was given by General Electric in their study of a Mars hard lander capsule; the final oral report is planned for 30 July 1968.

Study Guidelines

All studies were directed toward a 1973 Mars orbiter plus lander mission. The orbiter would gather data from a high inclination orbit and might act as a communications relay for the lander. The lander would land within 20° of the equator and return 10^7 to 10^8 bits, mostly imagery, from the surface in a lifetime of about 1 day. Longer lifetimes of about 90 days were also to be investigated. Various science instruments for the lander were specified including a facsimile camera, atmospheric pressure, temperature, humidity, composition, and wind velocity sensors, and an alpha-backscatter experiment for determining surface composition. Atmosphere entry experiments were also required. A maximum shroud diameter of 15 to 16 feet was specified allowing for a hammerhead Titan III launch vehicle. For the Martin study, entry weights ranging from 500 to 10,000 pounds were to be studied; "low" entry weights were specified for the McDonnell study; and apparently no entry weight constraint was placed on the G.E. study.

Langley has directed these studies toward what they feel is a representative scientific payload for a Titan class orbiter plus lander--less than Voyager, but still ambitious. The objectives were to investigate direct vs. orbital entry, soft vs. hard landing, and get an idea of the size of the entry vehicles required--particularly whether they could fit within the present 10 foot Titan shroud.

Results

The Martin study, directed toward comparing direct vs. orbital entry for a soft landing Mars capsule, concluded that the orbital entry mode has the advantage of much better operational flexibility and that the capsule could probably be built within the present 10 foot shroud limit. The direct entry capsule would require a larger aeroshell and additional development because of the higher heating loads. Six capsule point designs were discussed with capsule system weights of about 2000 pounds and landed weights of about 1000 pounds. These designs included Surveyor type landing gear with RADVS, vernier rocket engines, and autopilot. Most of the designs used parachutes instead of a main retro engine. Surface lifetime beyond two days was to be achieved with solar panels and radioisotope heaters. The Titan III-C/Centaur was considered for most of the designs, although Martin showed one design for a direct entry capsule with no orbiter to be launched on a Titan III-C. A large proportion of the study effort was apparently directed toward these point designs.

The McDonnell study, directed towards low-cost, low-weight, limited diameter soft landers, also strongly preferred the entry from orbit mode. Four point designs were prepared with about 1500 pounds total capsule weight and about 900 pounds landed weight. McDonnell found it necessary to assume a reduced landing surface slope environment ($<20°$) instead of the specified Voyager requirement ($<34°$) to fit the capsule within a 10-foot diameter shroud. Their designs were generally similar to the Martin designs.

The G.E. hard lander study strongly favored the entry from orbit over the direct entry mode. They showed three point designs, one small enough to fit the Titan shroud. Lander weights were about 900 pounds; entire capsule system weights were about 1800 pounds. The lander was to be retarded by a conventional aeroshell and a parachute, and would impact the Mars surface at about 100 fps. The lander consisted of a cylindrical instrument package (15" thick, 36" diameter) capable of withstanding a 1000 g shock. About 300 to 500 pounds of crushable impact limiter was attached to the circumference of the instrument package to limit the landing shock. Very little was said about the proposed material or the design technique used to size the impact limiter. Imaginative although dubious means of deploying experiments, antennas, and solar panels from the instrument package after landing were discussed. G.E. has considered the problem of the parachute landing on top of the capsule but has not developed a remedy except cutting the lander off about 5 seconds before impact and hoping Martian winds will blow the chute away.

G.E. also considered the modifications necessary to use a '71 Mariner orbiter with the hard landed capsule. Most of the orbiter subsystems would require some modifications. The spacecraft propulsion and structure subsystems would have to be completely redesigned for use with an orbital entry capsule because of the requirement to deboost the landing capsule into orbit.

Summary

The capsule point designs are in the 2000 pound (1000 pound landed) weight class, requiring the Titan III-C/ Centaur. They return a large amount of data compared to other probes which have been proposed for the first Mars entry mission. They can possibly be squeezed within the present Titan shroud, though all contractors showed several hammerheaded designs which were more comfortable from a capsule design standpoint.

Observations

The capsule data requirements are very ambitious. They seem more like scaled down Voyager requirements than the data return one might expect from the first Mars landing probe. Most of the data is imagery, and apparently the amount of imagery was specified to indirectly size the landing capsules.

The data requirements result in such a heavy payload that the hard landing subsystems weigh almost as much as the soft landing subsystems. If the data and payload requirements were reduced, the hard lander would probably weigh less because the weight of many of the soft landing subsystems is fixed.

For the payloads studied, the soft lander appears to be more advantageous because of packaging difficulties with the hard lander. G.E. seemed to be stretching to design a 1000 pound hard landed capsule. The landers were so large that they had difficulty fitting them on the entry vehicles, and the means of deploying the instruments from the semi-enclosed landing package were unconvincing.

W. B. Thompson for P.L.C.

1014-PLC-jan

P. L. Chandeysson

BELLCOMM, INC.

SUBJECT: Trip Report - 1973 Mars Lander Capsule Design Studies at Langley Research Center - Case 710

FROM: P. L. Chandeysson

DISTRIBUTION LIST

NASA Headquarters

Messrs. W. O. Armstrong/MTX
F. P. Dixon/MTY
E. W. Hall/MTG
D. P. Hearth/SL
W. Jakobowski/SL
R. S. Kraemer/SL
D. R. Lord/MTD
M. A. Mitz/SL
D. G. Rea/SL
A. D. Schnyer/MTV
J. W. Wild/MTE

Ames Research Center

L. Roberts/MA-2

Langley Research Center

I. Taback/159
C. Broome/159

Jet Propulsion Laboratory

J. Long/355
A. Herriman/32
K. Casani/292

Bellcomm, Inc.

F. G. Allen
G. M. Anderson
A. P. Boysen, Jr.
D. A. Chisholm
C. L. Davis
D. A. DeGraaf
J. P. Downs
D. R. Hagner
P. L. Havenstein
N. W. Hinners
B. T. Howard
D. B. James
J. Kranton
H. S. London
K. E. Martersteck
R. K. McFarland

Bellcomm (Cont'd)

Messrs. J. Z. Menard
G. T. Orrok
T. L. Powers
I. M. Ross
F. N. Schmidt
J. W. Timko
J. M. Tschirgi
R. L. Wagner
J. E. Waldo
All members, Division 101
Central Files
Department 1023
Library